APPENDIX A – IMT-2000 SYSTEM DESCRIPTION

The greater portion of the International Mobile Telecommunications for the Year 2000 (IMT-2000) system description presented below has been provided by the Federal Communications Commission (FCC). The last part of the system description presents specific technical parameters for selected mobile wireless technologies. These technologies were selected primarily because more technical data was available to describe these systems. The selection of these technologies for use in this assessment does not represent an endorsement or advocacy of those systems. Some of the IMT-2000 parameters used in the assessments were calculated using communications theory and represent notional parameters rather than the characteristics of existing hardware. The parameters contained in this appendix were used in the assessment to help establish the scope of sharing issues. Calculated distances, signal levels, and margins are principally intended to assist in further analyses and to help initiate dialogue between government and industry interest groups.

IMT-2000 and third-generation (3G) services are the names commonly used to refer to the next-generation mobile wireless telecommunications services. The 3G family of services, and the systems that will provide them, are intended to reflect a high degree of commonality and are to be compatible with each other. These services will support mobile and fixed users employing a wide range of devices including small pocket terminals, handheld telephones, laptop computers, and fixed-receiver equipment. Some International Telecommunication Union (ITU) Member States and Sector Members envision 3G services to be ubiquitous throughout the globe, as available in a remote part of a developing country as they are in an urban area in a highly developed country. The radiotransmission technologies (RTTs) providing for standardized 3G air-interfaces were initially agreed upon in November 1998 by the ITU's Radiocommunication Sector (ITU-R) Task Group 8/1 and were adopted as Recommendation M.[1] Sector Members and Member States are actively working in the ITU's Telecommunication Standardization (ITU-T) Sector to develop 3G signaling and communication protocols, network requirements needed to support expected 3G services, and service definitions for IMT-2000 applications. Table A-1, derived from ITU-T Draft Recommendation Q.1701,[2] describes selected essential capabilities of IMT-2000 systems.

[1] ITU-R Recommendation M. [IMT.SPEC], ITU-R Radiocommunication Assembly, Istanbul, Turkey, May 2000.

[2] ITU-T Draft Recommendation Q.1701, Geneva.

Table A-1. IMT–2000 Services/Capabilities

Capabilities to support circuit and packet data at high bit rates: - 144 kb/s or higher in high mobility (vehicular) traffic - 384 kb/s or higher for pedestrian traffic - 2 Mb/s or higher for indoor traffic
Interoperability and roaming among IMT–2000 family of systems
Common billing/user profiles: - Sharing of usage/rate information between service providers - Standardized call detail recording - Standardized user profiles
Capability to determine geographic position of mobiles and report it to both the network and the mobile terminal
Support of multimedia services/capabilities: - Fixed and variable rate bit traffic - Bandwidth on demand - Asymmetric data rates in the forward and reverse links - Multimedia mail store and forward - Broadband access up to 2 Mb/s

A.1 IMT-2000 SYSTEM CHARACTERISTICS

During preparations for the World Radiocommunication Conference 2000 (WRC 2000), the United States (US) committed to studying the feasibility of using the 1755-1850 MHz and 2500-2690 MHz bands (or parts thereof) for IMT-2000 operations. It was understood that such a study would include determining the impact of the operation of IMT-2000 systems on the systems already authorized to operate in these bands. The 1755-1850 MHz band is used in the US to support Government services, mostly military space operations, air combat training missions, and tactical communications operations. The 1710-1755 MHz portion of the 1700/1800 MHz band identified at WRC 2000 is currently in the process of becoming available for commercial use and it could be made available for IMT–2000 services. The 1850-1885 MHz portion of the same IMT-2000 band is already used to support personal communications services (PCS) operations in the US. The 2500-2690 MHz band is used to provide instructional television fixed services (ITFS) and multipoint distribution services (MDS) throughout the US.

In order to determine the impact of operating IMT-2000 systems in bands that are encumbered, it is necessary to assess to what degree the proposed and incumbent systems can co-exist in the same band. Stated in simplistic radio engineering terms, it is necessary to determine whether or not harmful interference is generated into one of the systems (incumbent or proposed) by the operation of the other(s). Furthermore, if it is determined that harmful interference is likely to occur, it is desirable to isolate the conditions under which it occurs and whether or not means exist to mitigate its effects and the costs associated with implementing such mitigation techniques.

The interference assessment mentioned above requires identification of the technical characteristics for the systems being studied and the ability to quantify the systems' performance. These characteristics are readily available for existing systems operating in the bands of interest. This is not the case however for all the parameters that are required to characterize IMT-2000 systems. These systems, many of which are in the planning or development stage, do not have well-defined or universally accepted values associated with every system parameter. Thus it is necessary to assume values for certain of the IMT-2000 system parameters that are to be used in the conduct of the interference studies. When assumptions had to be made concerning values to be used in characterizing IMT-2000 systems, an attempt was made to adopt values that are consistent with values documented in readily available material such as the reports and recommendations of the ITU-R, and reports or findings of industry-led working groups addressing IMT-2000 issues. Absent any other readily available information, FCC rules for second-generation (PCS) mobile systems were used as guides for 3G systems. In addition to values for the technical parameters themselves, it is also necessary to assume certain characteristics of the build-out of proposed IMT-2000 services, such as when they are likely to occur, whether there will be a time-phasing of the build-out, what regions of the globe are likely to support build-out earlier than others, and within a region, whether there will be a geographical preference i.e., urban versus suburban versus rural, for the build-out. These assumptions also were based on readily available material and information where possible.

In order to perform the compatibility assessments presented in the appendices, certain specific technical parameters needed. In these cases, communications theory and reviews of second-generation systems were used to help develop the needed parameters. Tables A-2 through A-5 present the final version of the technical parameters used in the calculations documented in the appendices. It should be noted that the assessments considered only one CDMA system simply to limit the scope of the initial assessment. Further analyses and discussions of sharing should consider all of the IMT-2000 technologies equally.

Table A-2. Characteristics of IMT-2000 Mobile Stations

Parameter	CDMA-2000	CDMA-2000	UWC-136 (TDMA)	UWC-136 (TDMA) GPRS/EDGE	W-CDMA
Carrier Spacing	1.25 MHz	3.75 MHz	30 kHz	200 kHz	5 MHz
Transmitter Power	100 mW	100 mW	100 mW	100 mW	100mW
Antenna Gain	0 dBi	0 dBi	0 dBi	0 dBi	0 dBi
Antenna Height	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m
Body Loss	0 dB	0 dB	0 dB	0 dB	0 dBi
Access Techniques	CDMA	CDMA	TDMA	TDMA	CDMA
Data Rates Supported	144 kb/s	384 kb/s	30 kb/s 44 kb/s	384 kb/s	384 kb/s
Modulation Type	QPSK/BPSK	QPSK/BPSK	π/4-DQPSK 8-PSK	GMSK 8-PSK	QPSK
Emission Bandwidth					
-3 dB	1.1 MHz	3.3 MHz[f]	0.026 MHz	0.18 MHz	3 GPP
-20 dB	1.4 MHz	4.2 MHz	0.034 MHz	0.22 MHz	TS25.101
-60 dB	1.5 MHz	4.5 MHz	0.036 MHz	0.24 MHz	
Receiver Noise Figure	9 dB	9 dB	9 dB	9 dB	9 dB
Receiver Thermal Noise Level	-113. dBm[a] -105 dBm[b]	-109 dBm[a] -100 dBm[b]	-121 dBm[a]	-113 dBm[a]	-109 dBm in 384 kb/s
Receiver Bandwidth					
-3 dB	1.10 MHz	3.30 MHz	0.03 MHz	0.18 MHz	N/A
-20 dB	1.6 MHz	4.7 MHz	0.04 MHz	0.25 MHz	N/A
-60 dB	3.7 MHz	11 MHz	0.09 MHz	0.58 MHz	N/A
E_b/N_o for $P_e = 10^{-3}$	6.6 dB	6.6 dB	7.8 dB	8.4 dB	3.1 dB*
Receiver Sensitivity[c]	-107 dBm	-103dBm	-113 dBm	-104 dBm	-106 dBm
Interference Threshold 1[d]	-119 dBm	-115 dBm	-127 dBm	-119 dBm	N/A
Interference Threshold 2[e]	-104 dBm	-100dBm	-111dBm	-103dBm	N/A

[a]In bandwidth equal to data rate
[b]In receiver bandwidth
[c]For a 10^{-3} raw bit error rate, theoretical E_b/N_o
[d]Desired signal at sensitivity, I/N = -6 dB for a 10 percent loss in range
[e]Desired signal 10 dB above sensitivity, S/(I+N) for a 10^{-3} bit error rate (BER)
[f]Shaded values were estimated.
* Assumes E_b/N_o for $P_e = 10^{-6}$ without diversity
N/A – Not Available
3GPP – Third-generation Partnership Project
BPSK – Binary phase shift keying
DQPSK – Differential quadrature phase shift keying
EDGE – Enhanced date rates for GSM evolution
GMSK – Gaussian minimum shift keying
GPRS – General Packet Radio Service
GSM – Global System for Mobile Communications
PSK – phase shift keying
QPSK – Quadrature phase shift keying

Table A-3. Characteristics of IMT-2000 Base Stations

Parameter	CDMA-2000	CDMA-2000	UWC-136 (TDMA)	UWC-136 (TDMA) GPRS/EDGE	W-CDMA
Operating Bandwidth	1.25 MHz	3.75 MHz	30 kHz	200 kHz	5 MHz
Transmitter Power	10 W	10 W	10 W	10 W	10 W
Antenna Gain	17 dBi per 120 deg. sector	17 dBi per 120 deg. sector	17 dBi per 120 deg. sector	17 dBi per 120 deg. sector	17 dBi per 120 deg. sector
Antenna Height	40 m	40 m	40 m	40 m	40 m
Tilt of Antenna	2.5 degs down	2.5 degs down	2.5 degs down	2.5 degs down	2.5 degs down
Access Techniques	CDMA	CDMA	TDMA	TDMA	CDMA
Data Rates Supported	144 kb/s	384 kb/s	30 kb/s 44 kb/s	384 kb/s	384 kb/s
Modulation Type	QPSK/BPSK	QPSK/BPSK	π/4-DQPSK 8-PSK	GMSK 8-PSK	QPSK
Emission Bandwidth					
-3 dB	1.1 MHz	3.3 MHz[f]	0.026 MHz	0.18 MHz	3 GPP
-20 dB	1.4 MHz	4.2 MHz	0.034 MHz	0.22 MHz	TS25.104
-60 dB	1.5 MHz	4.5 MHz	0.036 MHz	0.24 MHz	
Receiver Noise Figure	5 dB	5 dB	5 dB	5 dB	5 dB
Receiver Thermal Noise Level	-117dBm[a] -109dBm[b]	-113 dBm[a] -104 dBm[b]	-125 dBm[a]	-117 dBm[a]	-113 dBm in 384 kb/s
Receiver Bandwidth					
-3 dB	1.10 MHz	3.3 MHz	0.03 MHz	0.18 MHz	N/A
-20 dB	1.67 MHz	4.7 MHz	0.04 MHz	0.25 MHz	N/A
-60 dB	3.7 MHz	11 MHz	0.09 MHz	0.58 MHz	N/A
E_b/N_o for $P_e = 10^{-3}$	6.6 dB	6.6 dB	7.8 dB	8.4 dB	3.4 dB*
Receiver Sensitivity[c]	-111 dBm	-107 dBm	-117 dBm	-108 dBm	-110 dBm
Interference Threshold 1[d]	-123dBm	-119dBm	-131 dBm	-123 dBm	N/A
Interference Threshold 2[e]	-108 dBm	-104 dBm	-115 dBm	-107dBm	N/A

[a]In bandwidth equal to data rate
[b]In receiver bandwidth
[c]For a 10^{-3} raw bit error rate, theoretical E_b/N_o
[d]Desired signal at sensitivity, I/N = -6 dB for a 10 percent loss in range
[e]Desired signal 10 dB above sensitivity, S/(I+N) for a 10^{-3} BER
[f]Shaded values were estimated.
* Assumes E_b/N_o for $P_e = 10^{-6}$ without diversity
N/A = Not Available

Table A-4. IMT-2000 Traffic Model Characteristics[a]

Parameter	Value
Traffic Environments	Rural Vehicular Pedestrian In-building (Central business district)
Maximum Data Rates	Rural - 9.6 kb/s Vehicular - 144 kb/s Pedestrian - 384 kb/s In-building - 2 Mb/s
Cell Size	Rural - 10 km radius Vehicular - 1000 m radius Pedestrian - 315 m radius In-building - 40 m radius
Users per cell during busy hour	Rural - not significant Vehicular - 4700 Pedestrian - 42300 In-building - 1275
Percent of total uplink traffic >64 kb/s during busy hour	Rural - not significant Vehicular - 34% Pedestrian - 30% In-building - 28%
Percent of total downlink traffic >64 kb/s during busy hour	Rural - not significant Vehicular - 78% Pedestrian - 74% In-building - 73%
Average number of users per cell per MHz during busy hour assuming frequency duplex operation	Rural - not significant Vehicular < 64 kb/s - 16 > 64 kb/s - 4 Pedestrian < 64 kb/s - 150 > 64 kb/s - 64 In-building < 64 kb/s - 4 > 64 kb/s - 2

[a] Values in the table are for a mature network.

Table A-5. Rate of IMT-2000 Network Deployment[a]

	Calendar Year		
Local Environment	2003	2006	2010
Urban	10%	50%	90%
Suburban	5%	30%	60%
Rural	0%	5%	10%

[a] For some interactions the potential for interference will be influenced by the degree to which IMT-2000 networks are built out. This table identifies assumptions that will be used in the assessments with respect to the degree to which US IMT-2000 networks are developed following the granting of licenses. The levels of aggregate emissions for a fully mature IMT-2000 environment were taken from ITU-R 687.2 or other reference material as appropriate.